Institute for Environment and Health

The issues and implications of setting and applying indoor air quality guidelines

A report of an open seminar organised by the MRC Institute for Environment and Health and held at the University of Leicester on 6 April 2001

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Introduction

Outdoor air pollution has long been a focus for Government policy makers. The Government makes considerable efforts to protect human health from air pollutants both in the occupational environment, through occupational exposure standards, and in the outdoor environment, through standards and objectives. Yet we spend most of our time indoors, often at home. Therefore, should there not be similar efforts, through means such as published guidelines, to ensure safe and healthy indoor air?

Standards and guidelines for specific pollutants in indoor air have been developed in various countries worldwide, in some cases as long ago as the late 1970s. In the late 1980s, Health Canada (1989) produced an extensive list of proposed indoor air guideline values, with similar proposals coming more recently from Germany (Seifert *et al.*, 1999) and Norway (Becher *et al.*, 1999). In the USA, there is no uniform approach to indoor air guidelines; some states, such as California, are more proactive than others, and in the main the guidelines focus on specific issues such as smoking or ventilation. Australia has taken the approach of using indicators of good air quality, rather than defining quantitative guideline values (Brown, 1996). World Health Organization air quality guidelines (WHO, 1987), although not developed for the purpose, are intended to apply to indoor air. Indeed, recent WHO guidelines for Europe (WHO, 2000) include guidelines explicitly for three indoor pollutants: environmental tobacco smoke, man-made vitreous fibres and radon.

The MRC Institute for Environment and Health (IEH) has a long record of researching indoor air quality (IAQ) issues and, under an extensive research programme funded by the Department of the Environment, Transport and the Regions (DETR), has published thorough assessments and reports of exposure to, and the health effects of, a range of indoor air pollutants (IEH, 1996; 1998; 2000). A number of bodies, including DETR, the Department of Health (DH) and the European Chemical Industry Council (CEFIC) currently fund research on indoor air quality and its potential effect on health and well-being[b].

[a] The views expressed here are those of IEH and do not necessarily reflect those of any Government Department, Agency or other body.

[b] Two IEH databases, APRED and IERIE, provide up-to-date information on funding bodies, individual researchers and details of their organisations and research projects. Both are available at http://www.le.ac.uk/ieh/databases/databases.html. APRED focuses on UK researchers working in all areas of air pollution. The IERIE database contains information from across Europe and focuses on the indoor environment.

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In 1999, the Institute hosted a meeting, on behalf of DH, at which policy makers and scientists from Government Departments, research establishments and academia appraised the current understanding of IAQ and identified gaps in knowledge and areas requiring further consideration. Guidelines for IAQ were discussed at this meeting, and it was suggested that various consequences of developing such IAQ guidelines would require careful consideration before they could be adopted. Therefore, IEH, with support from DH and CEFIC, convened the open meeting reported here to explore further the issues that need to be addressed if the UK is to move towards setting guidelines for the quality of indoor air. The meeting attracted a broad range of speakers and participants from Government Departments, local authorities, academia, health authorities, research institutions and non-governmental organisations. This report summarises the meeting presentations and discussions.

Setting guidelines for indoor air quality

While IAQ guidelines could certainly contribute to health policy development, there are a number of foreseeable problems. For example, although outdoor air quality standards may be applicable to some indoor pollutants, this will not always be so, and a clear rationale will be needed for the development of guidance or setting of any guideline values. It will also be necessary to define what 'indoor air' means; that is, to which environments will any guidelines apply: the domestic environment, public buildings, schools and non-industrial workplaces? There is also the issue of individual susceptibility. The healthy adult worker sits at one end of the human susceptibility range, while the elderly and infirm occupy the other, and the guidelines will need to define whom they aim to protect. There are also practical questions about which pollutants require guidelines, how the pollutants should be measured and monitored and what the possible legal implications might be. Resources, both financial and manpower, will also be needed if IAQ guidelines are to be set, applied and observed. Counter to these problems are the various advantages that guidelines could convey. For example, they might form the basis of product and appliance emission standards, and be a part of information packages for the public, landlords or local authority housing or environmental health officers. Ultimately, the greatest potential benefit is that they could provide a means to protect health, particularly of more susceptible members of society.

The long history of policy and regulation directed at ambient air quality will be informative in any attempt to set IAQ guidelines. The Government has set out its aims for improving ambient air quality in the National Air Quality Strategy (NAQS), involving actions at a national and local scale. The main driver behind these efforts was the need to implement European Union legislation on ambient air quality. The NAQS is based on air quality standards set at levels considered to present little or no risk to health. Air quality objectives stem from these standards and consider economic efficiency, practicability, technical feasibility and time scales. These objectives are prescribed in legislation as the targets that local authorities must work towards through local air quality management arrangements.

Although the NAQS has been lauded, from a health perspective it is overall exposure to air pollutants, from a combination of outdoor, occupational and indoor environments that is important, especially for at-risk individuals. Whether there could be a National Indoor Air Quality Strategy is complicated by divisions in responsibilities for policy and delivery of actions within and between central and local Government. There is also the issue that the public are generally far less concerned about the quality of indoor air than about outdoor air quality problems. In particular, individuals' homes are not seen as appropriate subjects for such 'authoritarian' intervention.

Public concern, or lack of concern, may be influenced by several factors. For instance, people feel in control of their home environments but not outdoor air pollution caused by 'others' – car drivers, factories and, more recently, pyres of sheep and cattle. Even some pollution sources outside the individual's control may be better tolerated than others; for example, a 'polluting' factory may provide employment that makes it more acceptable than a nearby landfill site. Factors associated with individuals' feelings of control ('my home is my castle') and benefit or lack of benefit are potentially serious hurdles for the development and application of IAQ guidelines. On the whole, it is not easy to prescribe what people can or should do in their homes. Furthermore, if indoor air is of little concern to most people, there is little political drive pushing for action. It was suggested that, if people do show any concern about the air quality in their home, their reaction generally depends on whether they are home owners or tenants. Home owners' concerns focus on the possible effect on the value of their property, whereas tenants can seek to remedy a problem through their landlord.

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Government funds extensive research into the issue of IAQ, both reviews of the exposure to, and health effects of, various pollutants in the home, and applied research focusing on individuals' exposures and pollutant monitoring. However, with conflicting priorities, limited resources and a general lack of political drive, there is overall a low level of interest in IAQ. In part, this is due to the fact that indoor air pollutants are not a major threat to the health of most people. The same could be said of outdoor air pollution; however, public concern and the general wish to protect the health of more susceptible individuals in society underpins the policies and actions directed at outdoor air pollution, such as the NAQS.

If guidelines are used that define specific levels of pollutants, there should also be a means to measure and control those pollutants. Meeting participants also noted that guidance on what different levels of a pollutant actually mean would be helpful. For instance, is the air quality in a particular indoor environment 'normal' and is 'normal' necessarily 'good' or 'acceptable'? Indoor air quality guidelines could, therefore, have a clear role in helping to answer these questions; it was suggested that guidelines could in fact be descriptive rather than numerical, and probably should include elements of both.

Applying and meeting indoor air quality guidelines

If IAQ guidelines were to be developed in the UK, there would need to be some mechanism for applying and complying with them, whether through building regulations, emission standards or some other means. The current Building Regulations are intended to protect the health and safety of people in and around buildings, but apply only to new buildings and can have little effect on the existing building stock. Within the Building Regulations, the main area influencing IAQ is ventilation. Over the last few decades, efforts to improve buildings' energy efficiency have focused attention on reducing heat loss that occurs as a result of ventilation. Designing, installing and operating ventilation correctly is particularly important in view of the fact that leakage (infiltration) can allow as much air into a building as an installed ventilation system. If, as is planned, new buildings are made increasingly airtight, the balance between energy efficiency and air quality becomes more important.

To make Building Regulations more flexible and to encourage the use of low emitting materials, a performance-based approach is desirable. Such an approach could either:

1. set limits on the concentrations of indoor air pollutants to avoid an impact on health; or

2. set air supply rates to rooms to ensure the limiting concentrations of pollutants are not exceeded.

From a design and compliance viewpoint, the second approach is more practical, but both would still rely on quantitative IAQ guidelines in devising an approach to a performance-based method and in checking compliance. It is worth reiterating that the Building Regulations only apply to newly constructed, not existing buildings.

An alternative approach to the issue of applying and meeting IAQ guidelines could focus on emissions from combustion appliances and other sources in the home such as smoking, furniture, carpets and consumer products. Modelling studies can assist in investigating the factors that influence IAQ, including emissions. A probabilistic modelling framework, which predicts both indoor air pollution (INDAIR model) and personal exposures (EXPAIR) model), has recently been developed and was discussed at the meeting. The INDAIR model calculates frequency distributions of indoor air pollutants concentrations as a function of outdoor concentrations, indoor emission rates, ventilation rates, building filtration factor, room dimensions and deposition rates of pollutants, which are described by probability functions. The model allows the relative importance of indoor sources and home characteristics to be quantified and then, in conjunctions with the EXPAIR model, the influence of those sources on personal exposures to be estimated.

Source control may be a more practicable means by which to achieve indoor air quality improvements, rather than focusing on specific pollutants themselves. The difficulty with this approach is the breadth of potential sources of some pollutants. For instance, the main indoor sources of nitrogen oxides (NOx) emissions are gas cookers and boilers, but for volatile organic compounds (VOCs) there may be many potential sources – carpets, soft furnishings, chipboard, paints and consumer products. Furthermore, the design of appliances and products must assume they are used correctly. Although ventilation and extractor fans are often installed in kitchens, their effectiveness depends on the occupier actually using them, and using them

correctly. Another example is that, although gas cookers and other combustion appliances can produce carbon monoxide (CO), how the appliance is used is the important determinant of how much CO is produced. It was also suggested that, while labelling and advice about products and appliances is helpful, consumers generally make purchases based on price and other factors, not a performance label. Overall, if such a source-based approach were to be used, there would still need to be some form of target pollutant concentration at which to aim. Therefore, it would be advisable both to have controls on sources of pollutants and guidelines on acceptable indoor concentrations of those pollutants to allow emission standards to be set.

It is important that guidelines are supported by consistent, reliable and standardised methods of measuring and monitoring IAQ. A method should be acceptable to all with an interest in IAQ, including architects, builders, building owners, occupants, analysts and health professionals. The most authoritative bodies for defining such approaches are the European Committee for Standardization (CEN), International Standards Organisation (ISO) and British Standards Institution (BSI), the latter being the UK national standardisation body. Each of these bodies has technical committees whose focus is the measurement of pollutants in indoor air, either specifically or under the umbrella of 'air quality'. As well as efforts at measuring and monitoring, IAQ and the impact of interventions can be assessed by the use of models such as those described above. Such models could also be used to assess the impact of policy.

As the responsibility for actions to combat poor IAQ will rest with the owners or occupiers of a property, it will be important that Government (local and national) provides advice and information. Recently, this facet was explored as part of a project in Middlesbrough. The target audiences were parents and children, the long-term unemployed, the chronically ill and less active older people, the aim being to advise on IAQ in relation to their health through group work, one-to-one sessions, the local press and radio, competitions and roadshows.

Poor health, whether or not in relation to IAQ, cannot be addressed in isolation; there must be a holistic approach involving employment, housing, education and wealth*. Those providing advice to improve IAQ must consider factors beyond any details of ventilation and pollutant concentrations. For instance, recommending that people open their windows to increase the flow of fresh air into the home (assuming the outdoor air is indeed 'fresh') may run counter to crime prevention or energy efficiency advice. The more disadvantaged communities with the greatest burden of ill health also tend to be disenchanted and apathetic and may already be overloaded with initiatives about smoking, sensible drinking and the like. This makes it more difficult to get a new message across and actually change people's behaviour – there must be a means, a motive and an opportunity for people to change. As mentioned above, people are averse to being told what to do in their own homes and IAQ is probably a minor concern within a broader picture of health, education, income and other factors.

The implications of setting indoor air quality guidelines

If IAQ guidelines are developed, they may well have legal implications. Guidelines might be incorporated into legislation in various ways. For instance, one way is to set standards specifying ventilation rates. Another is to specify performance requirements. Both have the advantage of being readily understandable and allowing for different solutions to meet the requirements, but the disadvantage that they are difficult to revise and update. An alternative approach is to phrase legal requirements in general terms of 'satisfactory and appropriate ventilation' or maintaining indoor air at a safe and healthy quality. This helps to avoid the need for revision and updating by relying on informed expert judgment.

There are difficulties presented by the variety of premises to which any guidelines might apply, ranging from houses of various ages, construction and type to public buildings such as libraries, schools and perhaps offices or non-industrial workplaces (although occupational legislation would apply to the latter). Any guidelines may have to cover all these types and ages of building. It is also necessary to separate the responsibilities of the owner/landlord from the occupier/tenant. In the workplace, the current approach is to impose general duties on the employer and employees and to give detailed advice on how to meet those duties in particular areas. Applying IAQ guidelines in public buildings can be dealt with in a similar way,

* A previous IEH seminar (November 2000) addressed these broad issues relating to the impact of our environment on health and well-being. A report is available at http://www.le.ac.uk/ieh/update/update.html#HandWreport.

although placing duties on the public would be more problematic.

Currently, there are various standards applicable to dwellings, the most important being the Standard of Fitness for human habitation; however, this has little to say about air quality other than requiring the provision of adequate ventilation. A newly developed system, the Housing Health and Safety Rating System (HHSRS)* is intended to replace the current fitness standard. This takes a more hazard-based approach and shifts the focus from design, construction and maintenance to the potential effects of building defects. A surveyor must assess the likelihood of a harmful occurrence and the severity of the outcome(s). Among the twenty-four hazard categories included in the HHSRS are:

- damp and mould growth;
- air pollutants (CO, NOx, sulphur dioxide, VOCs and biocides);
- radiation, including radon, and
- asbestos

In the HHSRS, all dwellings, irrespective of age, construction and so on, are judged against an Ideal, defined as the currently perceived model that defines the safest performance criteria that can be expected. The HHSRS involves determining how far the conditions are from the Ideal. The clear advantage this provides is in encouraging continual improvement to reduce hazards, whereas the Fitness Standard provides a minimum and does not encourage going beyond that level to reduce hazards. Defined guidelines for IAQ would be very useful, in fact necessary, in providing accepted definitions of the Ideals for each hazard category.

If guidelines are set, who will be responsible for ensuring they are met? An IAQ guideline will only be useful if pollutant levels are, or at least can be, monitored. Local authorities already have a statutory duty to address ambient air quality through the NAQS and local air quality management plans, and there may, therefore, be a role for local authority environmental health or housing officers to provide the necessary expertise to deal with IAQ also. However, additional resources and commitment will be required for them to assume this role. It would be impractical for local authorities to police IAQ by monitoring every house in their jurisdiction. So, any investigative activities would have to be properly targeted and prioritised, whether on specific situations that are likely to cause problems or on susceptible sectors of the community. As well as providing a means to identify problems, the guidelines must be supported by clear information on the measures needed to comply with them. The difficulty is in getting building occupiers to act on any advice. Although raising awareness and providing information to the public is key to securing improvements, IAQ is not currently a cause for much public concern.

In view of the potential resource implications, it is important that the issue of IAQ guidelines should receive clear leadership and financial support from central Government, and that local Government and health authorities are sufficiently committed to whatever roles they are assigned.

Discussion

There are various reasons why establishing IAQ guidelines will not be as straightforward as setting standards and objectives for ambient air quality. People do not like to be 'nannied' by the Government. Furthermore, 'others' can be blamed for ambient air quality problems but it seems harder for people to accept responsibility for the quality of the air in their home. Together, such issues might hinder any political impetus to focus more attention on IAQ in general and guidelines in particular.

Some might question the need for guidelines in light of the fact that, in general, IAQ does not present a hazard to most people in most homes. However, if only a small proportion of susceptible people or properties is affected by poor IAQ across the UK, this might cause significant health consequences from a public health viewpoint. Also, it was clear from the discussions at the meeting that when representatives from local authorities and health authorities have to respond to queries from the public about IAQ, they would welcome some form of guidance, if only as to what is acceptable or 'normal' air quality. Therefore, if IAQ guidelines are to be set, they must have a defined aim and framework in which they will operate. Whatever the level of detail contained in any guidelines, it seems that there is a real need for such information and advice.

The economic consequences of guidelines and advice also need to be considered. A logical suggestion is for local authorities to take on responsibility for investigating IAQ problems and

* Further information is available [at May 01] from http://www.housing.detr.gov.uk/

offering advice and support, but in turn they will need economic and manpower resources to do so. Those who must remedy any problem will incur other costs. An important issue to consider is whether the benefits in terms of improved health and well-being will outweigh the more tangible costs of establishing guidelines, monitoring air quality and curing problems.

It is obviously impossible, and unnecessary, for local authorities, or whoever is given the responsibility for administering IAQ guidelines, to police them by monitoring every household or building at regular intervals. Therefore, guidelines would require a supporting framework defining the subgroups, buildings or air quality issues that are a priority. Modelling studies, such as those mentioned earlier, could help in developing such frameworks. For instance, one approach would be to use information on local conditions, building stock and activity patterns as inputs to a model. Thos could then simulate exposure distributions in a population, both under the current conditions and with proposed air quality management measures.

Furthermore, clear advice and promotion of the issue of IAQ will be necessary among home owners, landlords and tenants. Any such advice must consider the broader picture beyond, for instance, ventilation and choice of consumer products; simple remedies such as opening windows may well be good for air quality but may be good for burglars too.

There are two main approaches to the setting of guidelines, either to focus on pollutants themselves or on the source(s) of those pollutants. Focusing on pollutant emissions from specific sources will require a target at which to aim. Therefore, a combination of two approaches – guidelines on both the sources of pollutant emissions and on acceptable indoor concentrations of those pollutants – was seen as a logical way forward.

A common theme in this report has been the lack of concern expressed by most people about the quality of the air in their homes and the subsequent lack of impetus for policy action to address IAQ issues. This lack of concern may be wholly reasonable relative to other issues. However, policy development on health-related issues need not always be in response to public concern or opinion. If Government is to move further towards establishing IAQ guidelines, there must be a quorum of support from Government and other scientists, pressure groups and researchers. Furthermore, there must be a commitment to ensure that mechanisms are in place to develop the guidelines and ensure their acceptance by the people they will affect, which will include those having to set, apply or comply with them.

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Adrian Russell, Leicester City Council

Secretariat: Jane Stevens (Seminar Administrator); Simon Short (Seminar Manager)

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